

1     What is claimed is:

2  
3     1. A method of reducing chronic pain in animals by radio frequency (RF) neuromodulation of  
4     peripheral nerves of the animal, comprising the steps of:

5         attaching an active and a dispersive percutaneous probe at respective active and dispersive  
6     locations relative to a peripheral nerve of the animal associated with the pain to be reduced;

7         generating a first pulsed RF signal configured according to a first protocol for coupling to  
8     the active and dispersive probes via conductive leads to verify the location of the peripheral nerve;  
9     and

10         generating a second pulsed RF signal configured according to a second protocol for coupling  
11     to the active and dispersive probes via the conductive leads after the first pulsed RF signal is  
12     withdrawn, to modify propagation of pain sensation in the peripheral nerve without ablation thereof;  
13     wherein

14         at least the active percutaneous probe includes an RF cannula having a conductive spatulate  
15     blade conformably attached to a dorsal side of a curved, blunt-ended tubular tip portion of the RF  
16     cannula.

17  
18     2. The method of claim 1, wherein the step of attaching further comprises the steps of:

19         preparing the active and dispersive locations for attaching the active and dispersive probes to  
20     the patient; and

21         attaching the active and dispersive probes to the respective locations on the patient.

22  
23     3. The method of claim 2, wherein the step of preparing comprises the steps of:

24         determining the active location on the skin of the patient proximate a peripheral nerve of the  
25     patient associated with the pain to be reduced;

26         determining the dispersive location on the skin of the patient within approximately ten  
27     centimeters of the active location;

28         preparing the active and dispersive locations antiseptically;

29         applying a topical anesthetic to the active and dispersive locations; and

1 making an incision in the patient's skin in at least the active location.

2  
3 4. The method of claim 2, wherein the step of attaching comprises the steps of:

4 inserting a first RF cannula having the spatulate blade into the skin of the patient at the active  
5 location;

6 inserting a second RF cannula at the dispersive location; and

7 inserting RF electrodes into the first and second RF cannulas at the respective active and  
8 dispersive locations to establish an electrical connection between the active and dispersive locations;  
9 and

10 measuring the electrical impedance between the active and dispersive locations to verify that  
11 the impedance is below a predetermined limit.

12  
13 5. The method of claim 4, wherein the step of attaching further comprises the step of:

14 checking the insertion of the first and second RF cannula; and

15 repeating the measurement of the electrical impedance.

16  
17 6. The method of claim 1, wherein the step of generating a first pulsed RF signal comprises the steps  
18 of:

19 configuring an RF signal generator having an output for operation in a stimulator mode;

20 setting signal parameters according to the first protocol;

21 connecting active and dispersive signal leads from output terminals of the RF signal generator  
22 to the respective active and dispersive probes; and

23 gradually applying the first pulsed RF signal output while monitoring a response of the patient  
24 to verify correct location of the active and dispersive probes.

25  
26 7. The method of claim 6, wherein the stimulator mode comprises a first protocol limited to  
27 stimulating the peripheral nerve of the patient within a sensory range for the patient below a normal  
28 threshold of pain.

1 8. The method of claim 6, wherein the first protocol comprises RF signal parameters including at  
2 least a pulse amplitude, a pulse repetition rate and a pulse duration, wherein each parameter is  
3 characterized by a value.

4  
5 9. The method of claim 8, wherein typical values for an equine patient include a pulse amplitude  
6 adjusted from zero to a threshold of sensation, a pulse repetition rate of approximately 50 Hertz and  
7 a pulse duration of approximately 10 milliseconds.

8  
9 10. The method of claim 8, wherein respective values for pulse amplitude may vary from zero to ten  
10 volts, for pulse repetition rate may vary from 1.0 to 500 Hertz and for pulse duration may vary from  
11 one-tenth millisecond to 100 milliseconds.

12  
13 11. The method of claim 8, wherein the pulse repetition rate may be set to provide a one-shot pulse.

14  
15 12. The method of claim 6, wherein the step of generating a first pulsed RF signal further comprises  
16 the step of:

17 removing the output of the RF signal generator if monitoring the response of the patient  
18 during the step of gradually applying the output indicates an incorrect location or signal parameter  
19 value.

20  
21 13. The method of claim 1, wherein the step of generating a second pulsed RF signal comprises the  
22 steps of:

23 removing the active RF electrode from the active RF cannula after reducing the RF generator  
24 output to zero;

25 injecting a predetermined amount of a local anesthetic solution into tissue of the patient  
26 proximate the first location using an anesthetic metering device attached to the active RF cannula;  
27 and

28 replacing the anesthetic pumping device with the active RF electrode and verifying the  
29 electrical impedance is below a predetermined limit.

1 14. The method of claim 13, wherein the step of generating a second pulsed RF signal further  
2 comprises the steps of:

3        configuring the RF signal generator having an output for operation in a lesioning mode;  
4        setting signal parameters including according to the second protocol;  
5        verifying connection of the active and dispersive signal leads from output terminals of the RF  
6 signal generator to the respective active and dispersive probes; and  
7        applying the output according to the second protocol during a preset period while monitoring  
8 one or more responses of the patient.

9  
10 15. The method of claim 14, wherein the step of generating a second pulsed RF signal further  
11 comprises the step of:

12        removing the active RF electrode from the active RF cannula after reducing the RF generator  
13 output to zero;  
14        removing the active and dispersive RF cannulas from the patient; and  
15        applying a topical agent to the patient's skin after cleaning the area proximate the first and  
16 second locations.

17  
18 16. The method of claim 14, wherein the lesioning mode comprises a second protocol for applying  
19 a predetermined RF signal to the peripheral nerve in contact with the active RF probe to modify  
20 transmission of nerve impulses conveying chronic pain information.

21  
22 17. The method of claim 14, wherein the second protocol comprises:

23        RF signal parameters including at least a pulse amplitude, a pulse repetition rate, a pulse  
24 duration and a tip temperature, wherein each parameter is characterized by a value.

25  
26 18. The method of claim 17, wherein respective values for pulse amplitude may vary from zero to  
27 100 volts or zero to 50 watts or zero to 1.0 ampere, for pulse repetition rate may vary from 1.0 to  
28 500 Hertz, for pulse duration may vary from one-tenth millisecond to 100 milliseconds and for tip  
29 temperature may vary from body temperature to 90 Degrees centigrade.

1 19. The method of claim 17, wherein typical values for an equine patient being treated for pain  
2 associated with a leg injury include an RF signal applied for approximately five minutes and having  
3 a pulse repetition rate of approximately two Hertz, a pulse duration of approximately twenty  
4 milliseconds and an output amplitude controlled to maintain a tip temperature of approximately 48  
5 degrees centigrade.

6  
7 20. The method of claim 17, wherein typical values for an equine patient being treated for pain  
8 associated with a back injury include an RF signal applied for approximately seventy seconds and  
9 having a pulse repetition rate of approximately 500 Hertz, applied for a continuous duration and an  
10 output amplitude controlled to maintain a tip temperature of approximately 80 degrees centigrade.

11  
12 21. The method of claim 14, wherein the preset period comprises a value from zero to thirty minutes.

13  
14 22. The method of claim 14, wherein the predetermined limit of the electrical impedance is 350  
15 Ohms.

16  
17 23. The method of claim 13, wherein the local anesthetic solution is a carbocaine nerve block.

18  
19 24. The method of claim 1, wherein the chronic pain to be reduced includes pain occurring in the legs  
20 or back of animals.

21  
22 25. The method of claim 1, wherein the chronic pain to be reduced includes pain occurring in the legs  
23 or back of animals of the family equinidae.

24  
25 26. The method of claim 1, wherein the chronic pain to be reduced includes pain occurring in the legs  
26 or back of animals of the family equinidae, including chronic pain associated with at least one  
27 selected from the group consisting of deep digital flexor tendon, navicular disease, degenerative joint  
28 disease and high suspensor structures in the legs and facet joint degeneration and degenerative disc  
29 disease in spinal structures of the back.

1 27. The method of claim 2, wherein the step of attaching further comprises the steps of:  
2 inserting a first RF cannula having the spatulate blade into the skin of the patient at the active  
3 location;  
4 inserting first and second needles at the dispersive location; and  
5 inserting an RF electrode into the first RF cannula at the respective active location and  
6 connecting dispersive signal leads to the first and second needles at the dispersive location to establish  
7 an electrical connection, including tissues of the patient, between the active and dispersive locations;  
8 and  
9 measuring the electrical impedance between the active and dispersive locations to verify that  
10 the impedance is below a predetermined limit.  
11

12 28. The method of claim 27, wherein the step of attaching further comprises the step of:  
13 checking the insertion of the first and second RF cannula; and  
14 repeating the measurement of the electrical impedance.  
15

16 29. The method of claim 1, when being employed to treat pain in a large animal patient, wherein the  
17 step of generating a first pulsed RF signal is replaced by the step of palpating surface tissues of the  
18 large animal patient to verify location of the peripheral nerve associated with the pain to be reduced.  
19

20 30. Apparatus for reducing chronic pain in animals by radio frequency (RF) neuromodulation of a  
21 peripheral nerve of the animal, comprising:

22 a generator, for generating pulsed RF signals in at least a first mode and a second mode to  
23 be coupled via respective active and dispersive conductors through respective active and dispersive  
24 probes to respective active and dispersive locations on an animal patient's body, for reducing chronic  
25 pain experienced by the animal without ablation of the peripheral nerve;

26 a set of RF percutaneous probes including at least an active probe and a dispersive probe  
27 attached to the respective active and dispersive locations on the animal's body, at least the active  
28 probe further comprising an RF cannula having a conductive spatulate blade conformably attached

1 along a longitudinal axis to a dorsal side of a curved, blunt-ended tubular tip portion of the RF  
2 cannula; and

3 means adapted to connect with the active electrode for administering a liquid substance into  
4 the tissue of the animal that is in the active location.

5  
6 31. The apparatus of claim 30, wherein the first mode of the generator comprises:

7 a first pulsed signal configured according to a first protocol for stimulating the peripheral  
8 nerve of the patient within a sensory range for the patient below a normal threshold of pain to verify  
9 correct location of the active and dispersive probes.

10  
11 32. The apparatus of claim 31, wherein the first protocol comprises:

12 a plurality of RF signal parameters including at least a pulse amplitude, a pulse repetition rate  
13 and a pulse duration, wherein each signal parameter is characterized by a value.

14  
15 33. The apparatus of claim 32, wherein typical values for an equine patient include a pulse amplitude  
16 adjusted from zero to a threshold of sensation, a pulse repetition rate of approximately 50 Hertz and  
17 a pulse duration of approximately 10 milliseconds.

18  
19 34. The apparatus of claim 32, wherein respective values for pulse amplitude may vary from zero to  
20 ten volts, for pulse repetition rate may vary from 1.0 to 500 Hertz and for pulse duration may vary  
21 from one-tenth millisecond to 100 milliseconds.

22  
23 35. The apparatus of claim 32, wherein the pulse repetition rate may be set to provide a one-shot  
24 pulse.

25  
26 36. The apparatus of claim 30, wherein the second mode of the generator comprises:

27 a second pulsed signal configured according to a second protocol for applying a  
28 predetermined RF signal to the peripheral nerve in contact with the active probe to modify  
29 transmission of nerve impulses conveying chronic pain information;

1 wherein the second pulsed signal is applied during a preset period while monitoring one or  
2 more responses of the patient.

3  
4 37. The apparatus of claim 36, wherein the second protocol comprises:

5 a plurality of RF signal parameters including at least a pulse amplitude, a pulse repetition rate,  
6 a pulse duration and a tip temperature, wherein each signal parameter is characterized by a value.

7  
8 38. The apparatus of claim 37, wherein respective values for pulse amplitude may vary from zero to  
9 100 volts or zero to 50 watts or zero to 1.0 ampere, for pulse repetition rate may vary from 1.0 to  
10 500 Hertz, for pulse duration may vary from one-tenth millisecond to 100 milliseconds and for probe  
11 tip temperature may vary from body temperature to 90 Degrees centigrade.

12  
13 39. The apparatus of claim 37, wherein typical values for an equine patient being treated for pain  
14 associated with a leg injury include an RF signal applied for approximately five minutes and having  
15 a pulse repetition rate of approximately two Hertz, a pulse duration of approximately twenty  
16 milliseconds and an output amplitude controlled to maintain a probe tip temperature of approximately  
17 48 degrees centigrade.

18  
19 40. The apparatus of claim 37, wherein typical values for an equine patient being treated for pain  
20 associated with a back injury include an RF signal applied for approximately seventy seconds and  
21 having a pulse repetition rate of approximately 500 Hertz, applied for a continuous duration and an  
22 output amplitude controlled to maintain a tip temperature of approximately 80 degrees centigrade.

23  
24 41. The apparatus of claim 37, wherein the preset period comprises a value from zero to thirty  
25 minutes



1 42. The apparatus of claim 30, wherein the generator comprises:

2 signal generating means, including user-operated controls for setting signal parameter values  
3 and active and dispersive signal conductors for coupling an output RF signal from the signal  
4 generating means to the active and dispersive locations; and

5 control means for controlling the RF signal responsive to a predetermined probe tip  
6 temperature value.

7  
8 43. The apparatus of claim 42, wherein the generator further comprises:

9 readout means for providing parameter value information to the user; and  
10 measuring devices for measuring at least the probe tip temperature and a probe impedance  
11 between the active and dispersive probes and outputting measured values from the readout means.

12  
13 44. The apparatus of claim 30, wherein the active probe further comprises:

14 an RF cannula having an insulated tubular body for receiving an RF electrode therethrough;  
15 a hub at a first end of the tubular body for interfacing with the RF electrode upon its insertion  
16 into the tubular body; and

17 a blunt-ended and conductive tubular tip extending from a second end of the insulated tubular  
18 body, arcuate approximately along a longitudinal axis of the tubular body and including a conductive  
19 spatulate blade having an oval-shaped distal end and conformably attached to a dorsal side of the  
20 blunt-ended, conductive and arcuate tubular tip.

21  
22 45. The apparatus of claim 44, wherein the tubular tip extends from the second end of the tubular  
23 body by approximately one centimeter and is curved according to a predetermined radius through an  
24 included angle in the range of ten degrees to thirty degrees.

25  
26 46. The apparatus of claim 44, wherein the spatulate blade is attached to the tubular tip along a  
27 longitudinal center of the spatulate blade.

1 47. The apparatus of claim 44, wherein the spatulate blade extends laterally from either side of the  
2 tubular tip by a first predetermined dimension and longitudinally past a distal end of the tubular tip  
3 by a second predetermined distance.

4  
5 48. The apparatus of claim 44, wherein the spatulate blade conforms to a smooth, oval profile  
6 surrounding the end of the tubular tip.

7  
8 49. The apparatus of claim 44, wherein the tubular tip includes an orifice proximate a distal end of  
9 the tubular tip for releasing a liquid substance therefrom.

10  
11 50. The apparatus of claim 44, wherein the insulated tubular body is configured to receive an RF  
12 electrode configured as a thin, conductive wire that extends through the insulated tubular body into  
13 conductive contact with the tubular tip.

14  
15 51. The apparatus of claim 44, wherein the hub includes a locking interface for securing the RF  
16 electrode within the insulated tubular body.

17  
18 52. The apparatus of claim 30, wherein the dispersive probe comprises:

19 an RF cannula having an insulated tubular body for receiving an RF electrode therethrough;  
20 a hub at a first end of the tubular body for interfacing with the RF electrode upon its insertion  
21 into the tubular body; and

22 a blunt-ended and conductive tubular tip extending from a second end of the insulated tubular  
23 body, arcuate approximately along a longitudinal axis of the tubular body and including a conductive  
24 spatulate blade having an oval-shaped distal end and conformably attached to a dorsal side of the  
25 blunt-ended, conductive and arcuate tubular tip.

26  
27 53. The apparatus of claim 52, wherein the tubular tip extends from the second end of the tubular  
28 body by approximately one centimeter and is curved according to a predetermined radius through an  
29 included angle in the range of ten degrees to thirty degrees.

1 54. The apparatus of claim 52, wherein the spatulate blade is attached to the tubular tip along a  
2 longitudinal center of the spatulate blade.

3  
4 55. The apparatus of claim 52, wherein the spatulate blade extends laterally from either side of the  
5 tubular tip by a first predetermined dimension and longitudinally past a distal end of the tubular tip  
6 by a second predetermined distance.

7  
8 56. The apparatus of claim 52, wherein the spatulate blade conforms to a smooth, oval profile  
9 surrounding the end of the tubular tip.

10  
11 57. The apparatus of claim 52, wherein the tubular tip includes an orifice proximate a distal end of  
12 the tubular tip for releasing a liquid substance therefrom.

13  
14 58. The apparatus of claim 52, wherein the insulated tubular body is configured to receive an RF  
15 electrode configured as a thin, conductive wire that extends through the insulated tubular body into  
16 conductive contact with the tubular tip.

17  
18 59. The apparatus of claim 52, wherein the hub includes a locking interface for securing the RF  
19 electrode within the insulated tubular body.

20  
21 60. The apparatus of claim 30, wherein the dispersive probe comprises:  
22 first and second needles coupled to a common dispersive conductor for providing a return  
23 path to the generator for the pulsed RF signals.

24  
25 61. The apparatus of claim 30, wherein the means adapted to connect with the active probe for  
26 administering a liquid substance into the tissue of the animal that is in the active location includes a  
27 syringe.

1 62. The apparatus of claim 30, wherein the means adapted to connect with the active probe for  
2 administering a liquid substance into the tissue of the animal that is in the active location includes an  
3 anesthetic metering device  
4

5 63. A radio frequency (RF) cannula, comprising:

6 an insulated tubular body for receiving an RF electrode therethrough;  
7 a hub at a first end of the tubular body for interfacing with the RF electrode upon its insertion  
8 into the tubular body; and  
9 a blunt-ended and conductive tubular tip extending from a second end of the insulated tubular  
10 body, arcuate approximately along a longitudinal axis of the tubular body and including a conductive  
11 spatulate blade having a blade-shaped distal end and conformably attached to a dorsal side of the  
12 blunt-ended, conductive and arcuate tubular tip.  
13

14 64. The RF cannula of claim 63, wherein the tubular tip extends from the second end of the tubular  
15 body by approximately one centimeter and is curved according to a predetermined radius through an  
16 included angle in the range of ten degrees to thirty degrees.  
17

18 65. The RF cannula of claim 63, wherein the spatulate blade is attached to the tubular tip along a  
19 longitudinal center of the spatulate blade.  
20

21 66. The RF cannula of claim 63, wherein the spatulate blade extends laterally from either side of the  
22 tubular tip by a first predetermined dimension and longitudinally past a distal end of the tubular tip  
23 by a second predetermined distance.  
24

25 67. The RF cannula of claim 63, wherein the spatulate blade conforms to a smooth, oval profile  
26 surrounding the end of the tubular tip.  
27

28 68. The RF cannula of claim 63, wherein the tubular tip includes an orifice proximate a distal end of  
29 the tubular tip for releasing a liquid substance therefrom.

1 69. The RF cannula of claim 63, wherein the insulated tubular body is configured to receive an RF  
2 electrode configured as a thin, conductive wire that extends through the insulated tubular body into  
3 conductive contact with the tubular tip.  
4

5 70. The RF cannula of claim 63, wherein the hub includes a locking interface for securing the RF  
6 electrode within the insulated tubular body.  
7